ECMWF

European Flood Awareness System

EFAS *Bulletin*

December 2015 – January 2016

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DWD Copernicus European Commission SMHI KISTERS ELIMCO SISTEMAS Rediam ECMWF SHMU

The European Flood Awareness System (EFAS) produces European overviews of ongoing and forecasted floods up to 15 days in advance and contributes to better protection of the European citizens, the environment, properties and cultural heritage. It has been developed at the European Commission's in house science service, the Joint Research Centre (JRC), in close collaboration with national hydrological and meteorological services and policy DG's of the European Commission.

EFAS has been transferred to operations under the European Commission's COPERNICUS Emergency Management Service led by DG ENTR in direct support to the EU's Emergency Response Coordination Centre (ERCC) of DG ECHO and the hydrological services in the Member States.

ECMWF has been awarded the contract for the EFAS Computational centre. It is responsible for providing daily operational EFAS forecasts and 24/7 support to the technical system.

A consortium of Swedish Meteorological and Hydrological Institute (SMHI), Rijkswaterstaat (RWS) and Slovak Hydro-Meteorological Institute (SHMU) has been awarded the contract for the EFAS Dissemination centre. They are responsible for analysing EFAS output and disseminating information to the partners and the ERCC.

A Spanish consortium (REDIAM and ELIMCO) has been awarded the contract for the EFAS Hydrological data collection centre. They are responsible for collecting discharge and water level data across Europe.

A German consortium (KISTERS and DWD) has been awarded the contract for the EFAS Meteorological data collection centre. They are responsible for collecting the meteorological data needed to run EFAS over Europe.

Finally, the JRC is responsible for the overall project management related to EFAS and further development of the system.

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Cover image: Flooding from Storm Desmond, Ballyhaunis, County Mayo (Connacht), Ireland
Taken 08 December. Credit: Irish Defence Forces

EFAS news

News

The next release of the ECMWF forecasting system is planned for 8 March 2016. The most important change will be a significant resolution upgrade from 16 km to 9 km for the high resolution forecast and 32 km to 18 km for the ensemble. A report on the impact on the EFAS forecasts and scores will be presented in the next EFAS bulletin.

Meetings

GloFAS Hackathon
More than 60 hackers, web developers, forecasters and enthusiasts attended #FloodHack at ECMWF in Reading on 16-17 January 2016. The main idea of the event was to inspire new ideas for the Global Flood Awareness System (GloFAS) in terms of usage of data and dissemination of forecasts. A longer report from the event can be found below.

UNISDR Science and Technology Conference, 27-29 January 2016, Geneva
The first UNISDR Science and Technology Conference marked a crucial part of the drive to implement the Sendai Framework, which was adopted by the international community in March last year. Delegates collectively launched a new Science and Technology Partnership in support of disaster risk reduction, comprising over 65 agencies, science networks and organisations. The goals of the Partnership include how to better harness technology to improve risk assessment, strengthening of standards, collection of data and the deployment of efficient early warning systems. EFAS, as part of the Copernicus Emergency Management Service, was presented as an important European contribution to the Science and Technology Partnership.

Upcoming events

The 11th EFAS Annual Partner Meeting will take place on 6-7 April 2016 at NH Plaza de Armas Hotel in Sevilla, Spain. For more information please visit the EFAS web portal or contact the EFAS dissemination centre.

The 2016 HEPEX workshop with the theme "Ensemble for better hydrological forecasts" will take place in Quebec, Canada on June 6-8. The deadline for registration of abstracts is on the 25 Feb. For more information, please visit the website:
http://hepex.irstea.fr/2016-hepex-workshop/

EFAS results

Meteorological situation for December 2015 - January 2016

December continued on the same note as November ended with a westerly storm track hitting the western part of the British Isles and Scandinavia. No less than three severe storms caused record-breaking precipitation amounts (Figure 8 and Figure 9) and a large number of floods and flash floods (see reports below for details on the floods in UK and Ireland). December was dry for the southern part of Europe, and most of Europe was also unusually mild (Figure 12 and Figure 13).

January saw a change in the weather patterns driven by a shift from positive to negative NAO. This in turn caused the still strong westerlies to the south, bringing wet weather to the central and southern Europe (Figure 10 and Figure 11) and leading to numerous flood warnings in Eastern Europe and on the Iberian Peninsula. In northern Europe this led to a situation with stable cold conditions, especially over the Baltic region (Figure 14 and Figure 15).

Summary of EFAS flood and flash flood notifications for December 2015- January 2016

The 72 EFAS formal and informal flood notifications sent in December 2015 - January 2016 are summarized in Appendix - tables
Table 2 and their locations are shown in Figure 16 and Figure 17.

104 Flash Flood watches were sent to the corresponding EFAS partners. The locations are shown in Figure 18 and Figure 19 and Table 3.

Case study 1: UK Floods, December 2015

by Richard Davies, FloodList

December 2015 saw three storms – Desmond, Eva and Frank – conspire to make it the UK's wettest month on record. The heavy rainfall brought severe flooding to parts of Scotland, Ireland and northern England, where Honister Pass in Cumbria saw a record-breaking 341mm of rain in 24 hours (to 18:00 GMT, 05 December 2015).

More than 20,000 properties were flooded as a result of the extreme weather. UK insurers estimate they will need to pay out £1.3 billion in flood claims. But it could have been much worse. The Environment Agency said that flood defences in England had protected 12,500 homes during Storm Desmond and 10,900 during Storm Eva.

Flood defence equipment and personnel were moved from other areas of England to battle the floods affecting northern counties. The Environment Agency set up 2.3 km of temporary flood barriers to protect flood-threatened communities. Since the storms, the agency has carried out 16,000 inspections and identified around 660 flood defences needing repair work.

Storm Desmond
On 5 December, 2015, the Met Office issued a rare red "take action" warning for heavy rain in Cumbria and the Scottish Borders. By 14:00 that day, the Environment Agency had issued 17 severe flood warnings for areas in northern England. The counties of Cumbria and Lancashire suffered the worst of the floods. Thousands of homes were flooded in the city of Carlisle, where the River Eden reached record levels. One man died when he was swept away by the flooding River Kent near Kendal, in the county of Cumbria, where severe flood damage was also reported in Appleby, Keswick and Cockermouth.

In Lancashire, the village of St Michael's on Wyre was one of the worst hit after the River Wyre burst its banks. Heavy rains on 9 December led to further flooding in the village, and flood warnings remained in place in St Michael's several days after Storm Desmond had passed. St Michael's was flooded once again a few weeks later, after heavy rainfall from Storm Eva.

In Scotland, the River Nith burst its banks in Dumfries, flooding parts of the town. Around 1,000 people were evacuated in Hawick in the Scottish Borders as a result of flooding from the River Teviot. This exercise would be repeated after Storm Gertrude in late January 2016.

Storm Eva
Just 3 weeks after Storm Desmond, heavy rainfall from Storm Eva caused further flooding to areas in northern England. This time around some of the worst affected areas were parts of Yorkshire, including the cities of York and Leeds, and also Lancashire and Greater Manchester, including Salford, Bolton, Bury, Rochdale and Wigan. On 26 December, the River Aire in Leeds, Yorkshire, had reached record levels. By 27 December, the Environment Agency had issued 27 severe flood warnings, mostly for northern England. Around 9,000 properties in the north of England were flooded as a result of Storm Eva.

Storm Frank
Storm Frank brought further heavy rain on 30 December, causing severe flooding, this time mostly in Scotland, where the overflowing River Nith once again flooded Dumfries. The River Tweed and Eddleston Water caused flooding in Peebles and the River Dee in Ballater, Aberdeenshire. Three deaths were reported - in Cornwall, Moray and the Highlands - as a result of Storm Frank.

Case study 2: Flooding in Ireland Dec 2015-Jan 2016

by Jim Casey, Office of Public Works (OPW), Ireland

During December 2015 and January 2016, Ireland experienced exceptional and widespread flooding. All synoptic weather stations reported rainfall amounts that were well above the Long Term Average (LTA) for December and most reported double or triple their normal rainfall for the month. Wettest conditions were in county Cork where nearly all stations reported over 300% of LTA. Other counties with more than 240% of LTA in December included: Carlow, Westmeath, Mayo, Cavan, Dublin, Wexford, Galway and Roscommon. Three winter storms also affected Ireland in December: Desmond (4-5), Eva (23), and Frank (29-30).

Some of the largest flood events occurred between 6 and 13 December, predominantly In the West and North-west of the country. In other areas, the largest events occurred between 29 December and 6 January.

Many OPW surface water gauging stations in Ireland registered their highest levels on record during these periods.

From 3 December 2015 to 6 January 2016, a total of 19 Flood Notifications for Ireland were issued from EFAS. These comprised three Formal Flood Notifications, seven Informal Flood Notifications and nine Flash Flood Notifications and details are provided in Table 2 and Table 3.

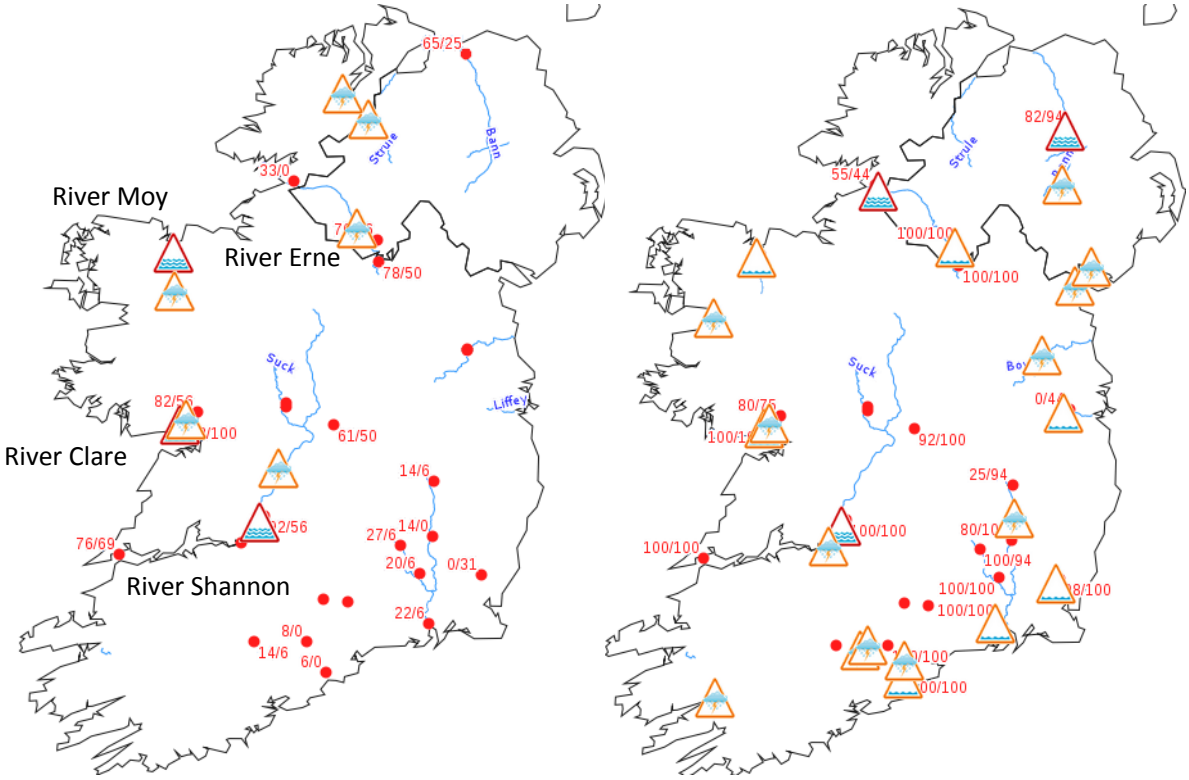

Figure 1. ***EFAS Forecasts on (a) 3 Dec 2015 at 00UTC (left) and (b) 29 Dec 2015 at 12 UTC (right)***

On the morning of 3 December a Formal Flood Notification was issued for the Shannon basin predicting the 5-year threshold to be exceeded on 7 December with the earliest peak occurring on 10 December. The 5-year threshold was actually exceeded on 6 December in the mid Shannon catchment at Banagher, one day earlier than predicted. After this, the River Shannon remained high and reached its maximum level on record at Banagher on 5 January 2016. The flooding on the River Shannon during this period was severe and caused widespread damage to roads, land and properties. All gauges on the River Shannon registered their highest levels on record.

A Formal Flood Notification was also issued for the Clare and Moy basins on 3 December predicting the 5-year threshold to be exceeded on 4 December with the earliest peak occurring on 6th December. The 5-year threshold was exceeded on both of these rivers one day later than forecast which provided two days' advance notice of the event. This event was the highest on record for all gauges on the River Moy.

The first Informal Flood Notification in December was issued on the 4 for the Erne basin. This correctly predicted that the 5-year threshold would be exceeded on 5 December at Belturbet. The River Erne remained above the 5-year threshold for the next four weeks, and a Formal Flood Notification was issued on 29 December that predicted the peak to be reached on 4 January 2016. The actual peak was reached on 2 January, at Belturbet and was the second highest level on record at that location.

Overall, EFAS Formal and Informal Flood Notifications performed well. All of those issued gave at least one day advance notice of the 5 year thresholds being exceeded in the respective basins. The durations of advance notice provided by the Formal and Informal Flood Notifications are presented in chronological order in Table 1 below.

Table 1 ***Advance Notice provided by EFAS Formal and Informal Flood Notifications during December 2015 and January 2016 (Formal Notifications in red)***

Predicted (EFAS)					Actual Event		
Date Received	**Notification Type**	**River Basin**	**Start of Event**	**Earliest Peak**	**Start of Event**	**Earliest Peak**	**Advance Notice***
03/12/2015	**Formal**	**Clare and Moy**	**04/12/2015**	**06/12/2015**	**05/12/2015**	**07/12/2015**	**2 days**
03/12/2015	**Formal**	**Shannon**	**07/12/2015**	**10/12/2015**	**06/12/2015**	**10/12/2015**	**3 days**
04/12/2015	Informal	Erne	05/12/2015	08/12/2015	05/12/2015	10/12/2015	1 day
26/12/2015	Informal	Suir & Barrow	26/12/2015	31/12/2015	30/12/2015	30/12/2015	4 days
27/12/2015	Informal	Blackwater	26/12/2015	31/12/2015	30/12/2015	30/12/2015	3 days
27/12/2015	Informal	Slaney	26/12/2015	31/12/2015	30/12/2015	30/12/2015	3 days
28/12/2015	Informal	Clare	28/12/2015	31/12/2015	29/12/2015	01/12/2015	1 day
28/12/2015	Informal	Moy	28/12/2015	31/12/2015	30/12/2015	31/12/2015	2 days
29/12/2015	**Formal**	**Erne**	**29/12/2015**	**04/01/2016**	**05/12/2015**	**02/01/2016**	**None****
29/12/2015	Informal	Liffey	29/12/2015	30/12/2015	no data	no data	------

Due to the widespread nature and severity of the flooding experienced in Ireland during December 2015 and January 2016, the Copernicus EMS mapping service was activated following a formal request from Ireland. This mapping proved very helpful during the emergency situation to identify the scale and extent of flooding and is now being used for post event review (http://emergency.copernicus.eu/mapping/list-of-components/EMSR149).

EFAS was also used extensively (daily) during this flood emergency situation to brief the National Coordination Group (NCG) on Severe Weather of the ongoing and forecast flood situation and it proved to be very valuable for this purpose.

Presentation of the EFAS Meteorological Data Collection Centre

The new EFAS framework contract for the EFAS Meteorological Data Collection Centre (MDCC) was awarded to a consortium consisting of KISTERS – a global leader providing solutions for hydrological and meteorological data processing – and the Global Precipitation Climatology Centre (GPCC) operated by the "Deutscher Wetterdienst" (DWD). We welcome them as new members of the operational EFAS system, and below follows a description of the consortium.

The team is interdisciplinary and contains experts from information technology, system design, data processing, quality assurance as well as meteorologists Dr. Christoph Schweim (Solution Manager, KISTERS) who is responsible for the overall project management. He and Dr. Andreas Becker (Head of GPCC, GPCC/DWD) ensure that the new MDCC is continuously operating and delivering high quality data products to the computational center (ECMWF). The software backbone for this operation is the KISTERS Information System "WISKI", a water resource management technology that is used by national and regional authorities all over Europe. As a joint effort Dr. Andreas Becker and Dr. Markus Ziese (GPCC) define the content structure and processes together with Dr. Christoph Schweim and Damien Pichon (KISTERS).

Figure 2. The GPCC-DWD team consists of Dr. Andreas Becker (left), data provider management, meteorologist and head of GPCC/DWD and Dr. Markus Ziese (right), meteorological data processing expert and analyst.

Figure 3. The KISTERS team consists of Dr. Christoph Schweim (left), solution manager meteorology and Damien Pichon (right), senior consultant.

The core tasks of the GPCC team of experts will be the liaisons with the provider, collection, harmonization and validation of near real time meteorological data, as well as the quality control. The GPCC recently started the recruitment process to step up their capacity with another expert. KISTERS will extend their functionality by adding an additional data importer, validation routines and most importantly by optimized point-to-raster calculations that will generate the gridded fields. The entire software and hardware infrastructure of the MDCC will be hosted at the KISTERS Data Centre, where a team of IT experts and key supporters will ensure a continuous 24/7 operation.
The KISTERS/GPCC Team is highly motivated and works closely together to prepare the launch of the new EFAS Meteo Data Collection Centre.

#FloodHack - inspires ideas to improve global flood awareness

By Fredrik Wetterhall

ECMWF's Hackathon on 16-17 January brought together participants from ECMWF, universities, environmental consultancies and software development companies. The goal was to explore ways of making GloFAS more user-friendly. GloFAS already provides pre-operational global forecasts of extreme flood events and it is envisioned that it will become fully operational in the future.

Figure 4. Florian Pappenberger explains the reason for the Hackathon and examples of the use of GloFAS.

After some introduction to GloFAS and brainstorming around challenges that needed to be addressed, the participants were asked to form teams and formulate a problem that could be solved within the time given. Five teams entered the competition and set out to create prototypes that would impress the judges in terms of its technical solution, "wow factor" and innovation. After pushing the ideas and the development through the night, a panel of judges decided on three winning entries:

- LIVE (Logistic and Infrastructure Visual Evaluation) Using GloFAS forecast information to create a 'Time to respond' map - Sets out to summarise GloFAS forecast information into a 'Time to respond' map that helps decision-making before and during a flood emergency. This is presented in a user-friendly way with key statistics which could help decision-making.
- FloodIT - Provides more intuitive information based on the GloFAS output to help local users understand their situation.

Figure 5. All the participants of the #FloodHack. Photo: Silke Zollinger

- Interception
  A Flood Awareness Education Platform
  An educational game/online interactive platform to help inform people about what they should be doing when a flood watch/warning alert is issued in their region.
  Also, the game/platform will educate them on what to do during and after a flood event.

The #FloodHack page on the ECMWF website has links to all the entries, along with photos from the weekend.

Verification

Figure 6 shows the EFAS headline score, the Continuous Ranked Probability Skill score (CRPSS) run by the ECMWF ensemble forecast. The recent months shows again an increase in the score, which is partially due to the well forecasted wet winter in Western Europe.

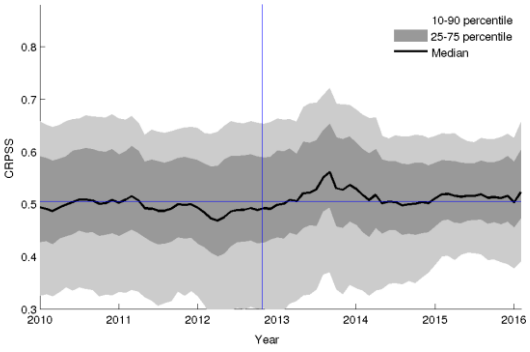

Figure 6. CRPSS for EFAS using the ECMWF ENS for catchments over 2000 km². The scores are filtered with a 12-month running average and the reference forecast is the climate.

2016 was in terms of flooding a year of contrasts, where most of the year was relatively calm apart from some major flash floods. However, the last four months were very dramatic and active, which is reflected in the large number of notifications sent (Figure 7).

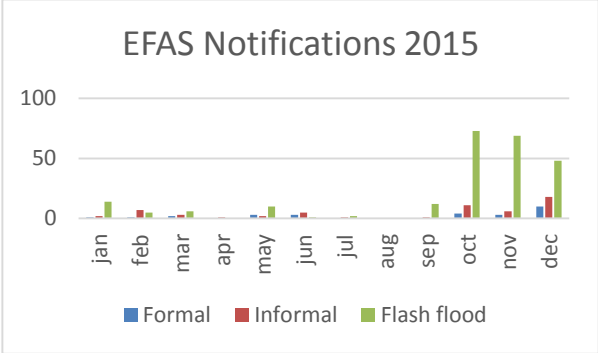

Figure 7. Flood and flash flood notifications (previously alerts and watches) sent by EFAS in 2015.

Team publications

Stephens, E., Day, J. J., Pappenberger, F. and Cloke, H. L., Precipitation and floodiness, Geophysical Research Letters, 42 (23), doi: 10.1002/2015GL066779}, 10316--10323, 2015

Hirpa, F.A., Salamon, P., Alfieri, L., Thielen-del Pozo, J., Zsoter, E., Pappenberger, F., The effect of reference climatology on global flood forecasting, Journal of Hydrometeorology, doi: http://dx.doi.org/10.1175/JHM-D-15-0044.1, 2016

Kauffeldt, A., Wetterhall, F., Pappenberger, F., Salamon, P. and Thielen J., Technical review of large-scale hydrological models for implementation in operational flood forecasting schemes on continental level, Environmental Modelling & Software 75, 68-76, 2016.

Orth, R., Dutra, E. and Pappenberger, F., Improving weather predictability by including land-surface model parameter uncertainty, Monthly Weather Review, doi: http://dx.doi.org/10.1175/MWR-D-15-0283.1, 2016

Appendix - figures

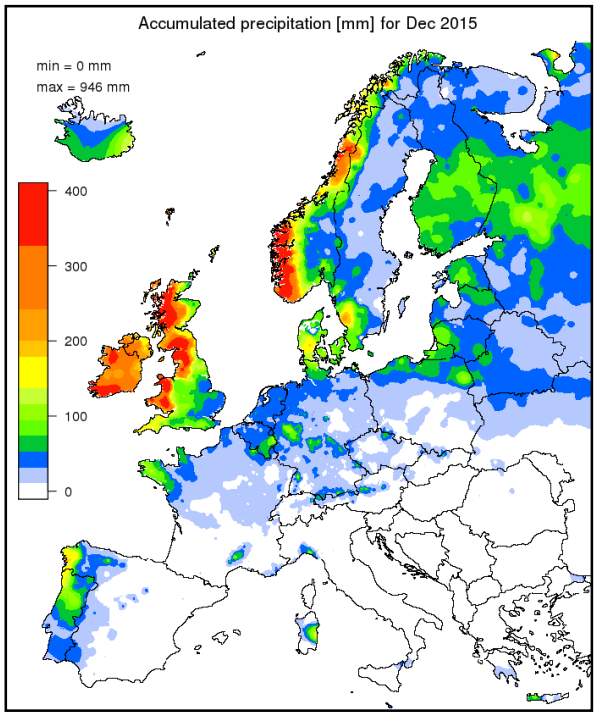

Figure 8: Accumulated precipitation [mm] for December 2015.

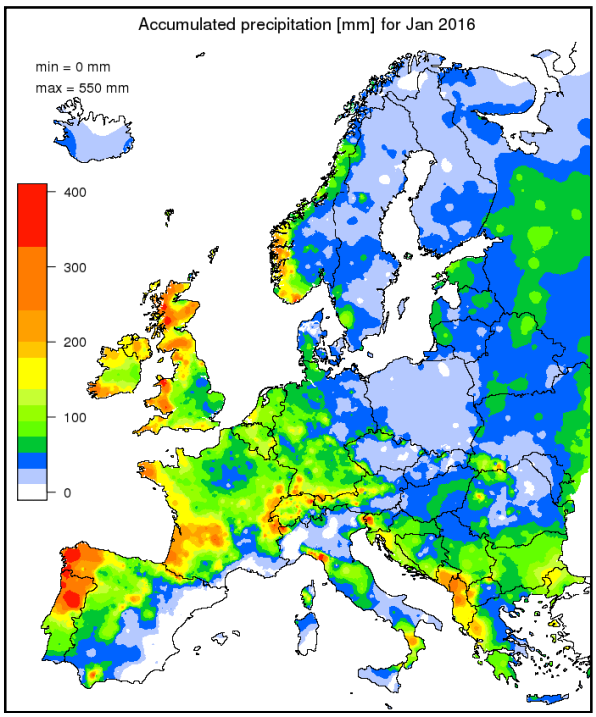

Figure 10: Accumulated precipitation [mm] for January 2016.

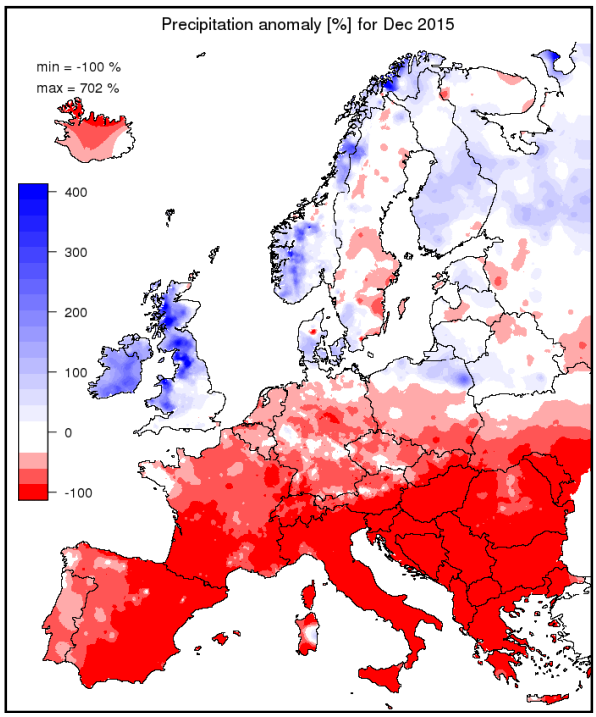

Figure 9: Precipitation anomaly [%] for December 2015, relatively to a long term average (1990-2011). Blue (red) denotes wetter (drier) conditions than normal.

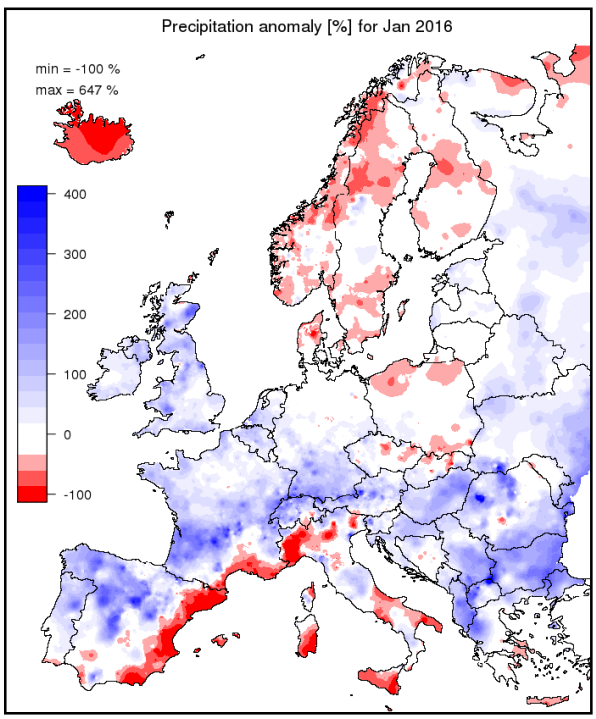

Figure 11. Precipitation anomaly [%] for January 2016, relatively to a long term average (1990-2011). Blue (red) denotes wetter (drier) conditions than normal.

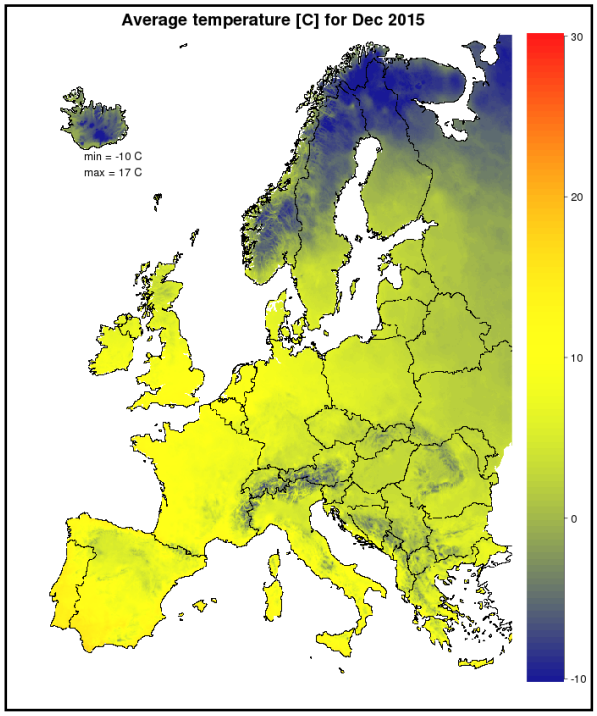

Figure 12: Mean temperature [°C] for December 2015.

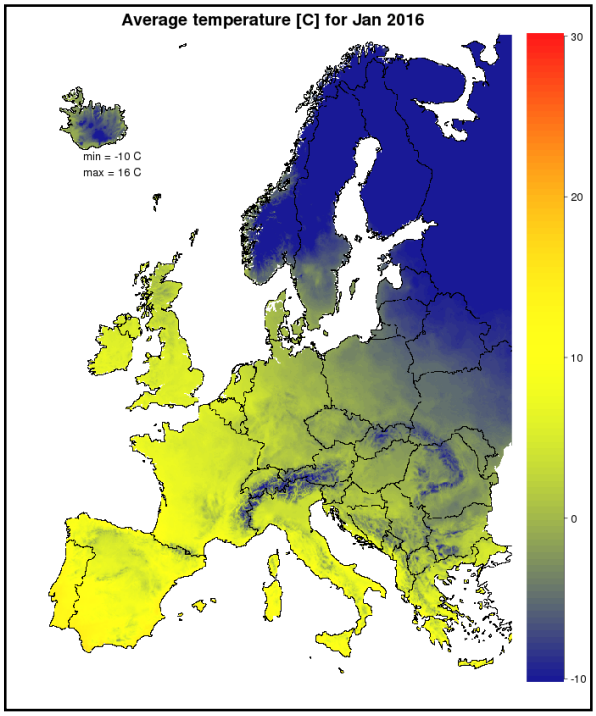

Figure 14: Mean temperature [°C] for January 2016.

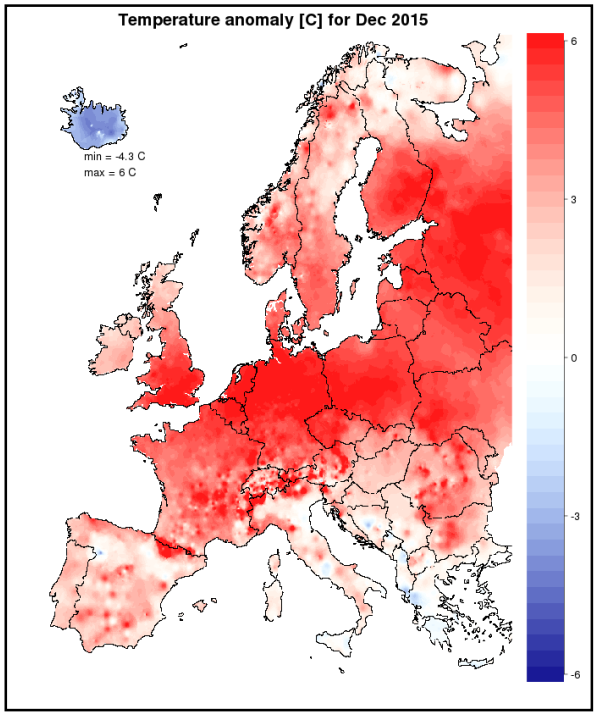

Figure 13: Temperature anomaly [°C] for December 2015, relatively to a long term average (1990-2011). Blue (red) denotes colder (warmer) temperatures than normal.

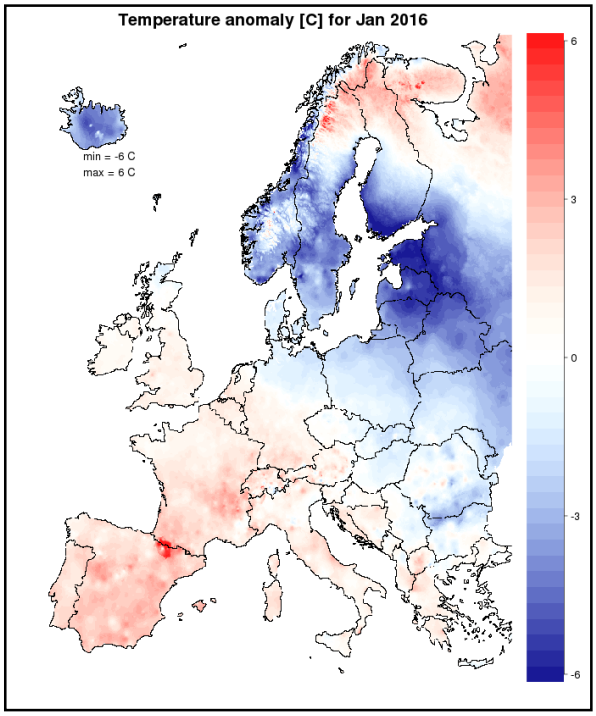

Figure 15: Temperature anomaly [°C] for January 2016, relatively to a long term average (1990-2011). Blue (red) denotes colder (warmer) temperatures than normal.

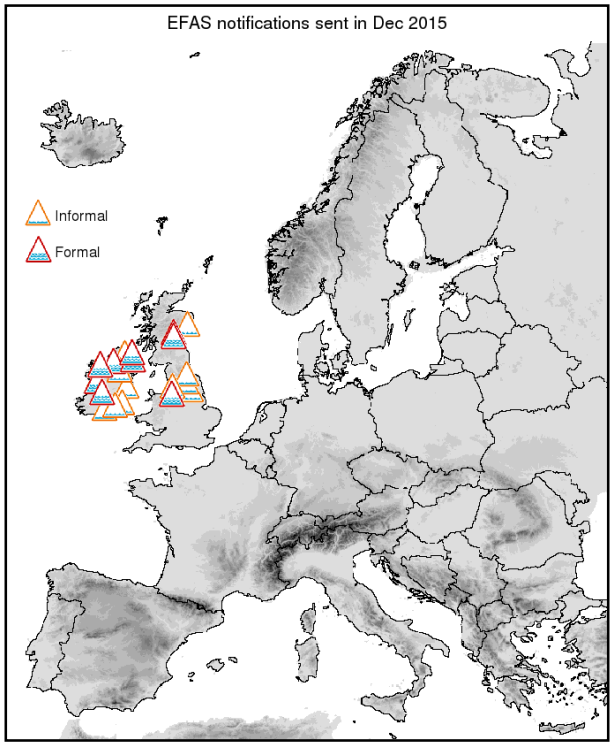

Figure 16: EFAS flood alerts and watches for December 2015.

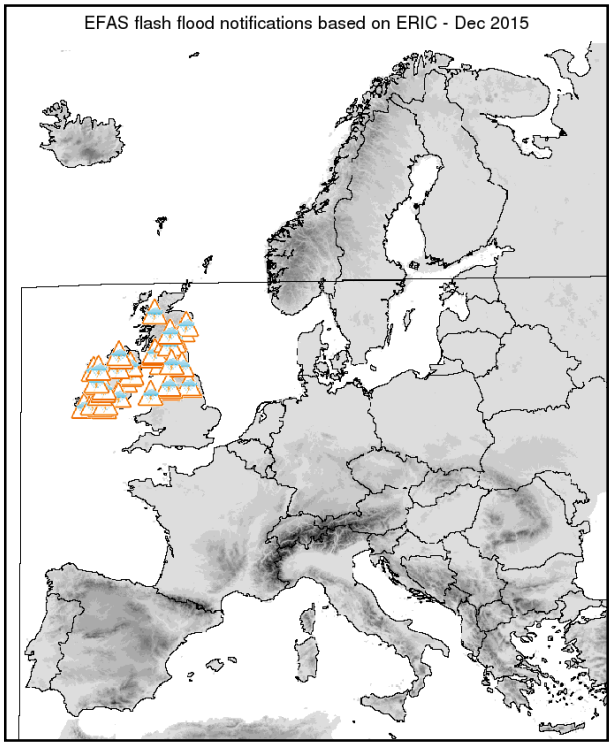

Figure 18: Flash flood reporting points for December 2015.

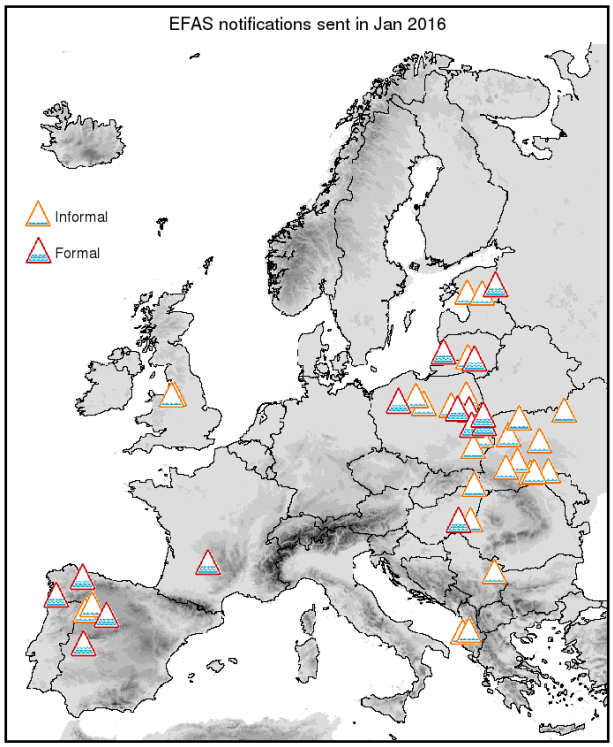

Figure 17: EFAS flood notifications for January 2016.

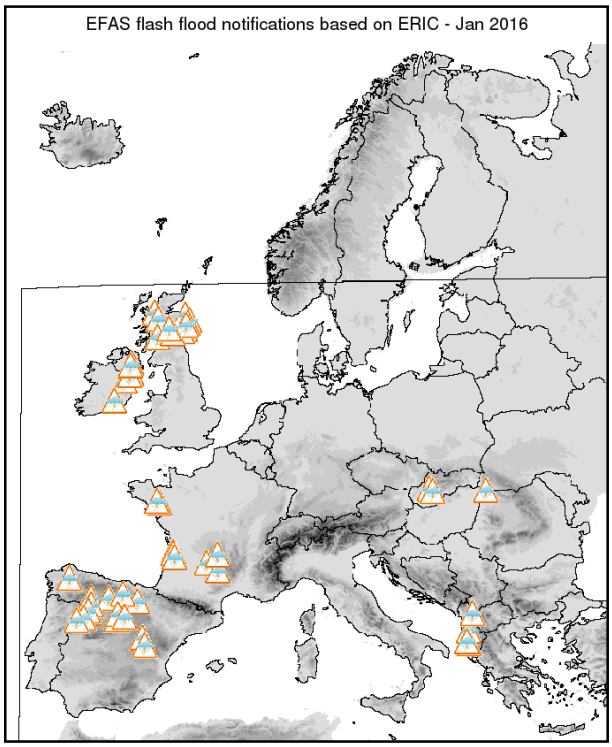

Figure 19. Flash flood reporting points for January 2016.

Appendix - tables

Table 2: EFAS flood notifications sent in December 2015 - January 2016

Type	Forecast date	Issue date	Lead time*	River	Country
Formal	01/12/2015 00 UTC	01/12/2015	0	Mersey	United Kingdom
Informal	01/12/2015 00 UTC	01/12/2015	0	Ribble	United Kingdom
Formal	02/12/2015 12 UTC	03/12/2015	2	Clare	Irish Republic
Formal	02/12/2015 12 UTC	03/12/2015	4	Shannon	Irish Republic
Formal	02/12/2015 12 UTC	03/12/2015	0	Moy	Irish Republic
Informal	03/12/2015 00 UTC	03/12/2015	1	Ouse	United Kingdom
Informal	02/12/2015 12 UTC	03/12/2015	1	R. Tees	United Kingdom
Formal	04/12/2015 00 UTC	04/12/2015	2	Bann	United Kingdom
Informal	04/12/2015 00 UTC	04/12/2015	1	Costal zone	United Kingdom
Informal	04/12/2015 00 UTC	04/12/2015	1	Tay	United Kingdom
Informal	04/12/2015 00 UTC	04/12/2015	1	Tay	United Kingdom
Informal	03/12/2015 12 UTC	04/12/2015	2	Erne	Irish Republic
Informal	08/12/2015 00 UTC	08/12/2015	0	Mersey	United Kingdom
Informal	17/12/2015 00 UTC	17/12/2015	2	Ribble	United Kingdom
Formal	17/12/2015 12 UTC	18/12/2015	2	Mersey	United Kingdom
Informal	24/12/2015 12 UTC	25/12/2015	0	Bann	United Kingdom
Informal	25/12/2015 12 UTC	26/12/2015	0	Ouse	United Kingdom
Informal	25/12/2015 12 UTC	26/12/2015	1	Suir & Barrow	Irish Republic
Formal	26/12/2015 12 UTC	27/12/2015	3	Tay	United Kingdom
Formal	26/12/2015 12 UTC	27/12/2015	3	Tay	United Kingdom
Informal	26/12/2015 12 UTC	27/12/2015	0	Slaney	Irish Republic
Informal	26/12/2015 12 UTC	27/12/2015	0	Blackwater	Irish Republic
Formal	28/12/2015 00 UTC	28/12/2015	2	Bann	United Kingdom
Informal	28/12/2015 00 UTC	28/12/2015	2	Dee	United Kingdom
Informal	27/12/2015 12 UTC	28/12/2015	1	Moy	Irish Republic
Informal	27/12/2015 12 UTC	28/12/2015	0	Clare	Irish Republic
Formal	28/12/2015 12 UTC	29/12/2015	1	Erne	Irish Republic
Informal	28/12/2015 12 UTC	29/12/2015	1	Liffey	Irish Republic
Informal	02/01/2016 12 UTC	03/01/2016	2	Shkumbin	Albania
Formal	05/01/2016 00 UTC	05/01/2016	3	Tietar	Spain
Formal	05/01/2016 00 UTC	05/01/2016	3	Tietar	Spain
Informal	06/01/2016 00 UTC	06/01/2016	0	Shkumbin	Albania
Informal	05/01/2016 12 UTC	06/01/2016	0	Mersey	United Kingdom
Formal	07/01/2016 00 UTC	07/01/2016	0	Duoro, above Pisuerga	Spain
Formal	07/01/2016 12 UTC	08/01/2016	0	Navia	Spain
Formal	07/01/2016 12 UTC	08/01/2016	3	Mino	Spain
Formal	07/01/2016 12 UTC	08/01/2016	2	Dordogne, above Isle	France
Formal	08/01/2016 12 UTC	09/01/2016	4	Bug, above Mukhavyets	Belarus
Formal	08/01/2016 12 UTC	09/01/2016	5	Bug, above Mukhavyets	Poland
Informal	09/01/2016 00 UTC	09/01/2016	3	Koros, Crisul	Hungary
Informal	08/01/2016 12 UTC	09/01/2016	2	Esla, below Orbigo	Spain
Informal	09/01/2016 12 UTC	10/01/2016	2	Dnester, above Reut	Ukraine
Formal	11/01/2016 00 UTC	11/01/2016	2	Wieprz	Poland
Formal	11/01/2016 00 UTC	11/01/2016	4	Lower Koros section	Hungary
Informal	11/01/2016 00 UTC	11/01/2016	1	San	Poland
Informal	10/01/2016 12 UTC	11/01/2016	1	Timok	Serbia

Informal	10/01/2016 12 UTC	11/01/2016	2	Bodrog	Slovakia
Informal	12/01/2016 00 UTC	12/01/2016	1	Douro	Spain
Informal	19/01/2016 00 UTC	19/01/2016	3	Mersey	United Kingdom
Formal	22/01/2016 00 UTC	22/01/2016	5	Minija	Lithuania
Formal	22/01/2016 00 UTC	22/01/2016	6	Bug, below Mukhavyets	Poland
Formal	21/01/2016 12 UTC	22/01/2016	5	Gwda	Poland
Informal	24/01/2016 00 UTC	24/01/2016	3	Neman, section Nevezis -	Lithuania
Formal	24/01/2016 12 UTC	25/01/2016	3	Neris	Lithuania
Informal	25/01/2016 00 UTC	25/01/2016	3	Dnester, above Reut	Ukraine
Informal	24/01/2016 12 UTC	25/01/2016	1	Mersey	United Kingdom
Informal	24/01/2016 12 UTC	25/01/2016	3	Dnester, above Reut	Ukraine
Informal	26/01/2016 00 UTC	26/01/2016	3	Goryn, above Sluch	Ukraine
Informal	26/01/2016 00 UTC	26/01/2016	0	Drweca	Poland
Informal	25/01/2016 12 UTC	26/01/2016	1	Wista, below Brda	Poland
Informal	25/01/2016 12 UTC	26/01/2016	2	Narew	Poland
Informal	25/01/2016 12 UTC	26/01/2016	3	Pripyat section	Ukraine
Formal	27/01/2016 00 UTC	27/01/2016	3	Velikaya	Estonia
Informal	27/01/2016 00 UTC	27/01/2016	1	Sluch	Ukraine
Informal	27/01/2016 00 UTC	27/01/2016	2	Emajogi	Estonia
Informal	26/01/2016 12 UTC	27/01/2016	2	Wieprz	Poland
Informal	26/01/2016 12 UTC	27/01/2016	1	Dnester, above Reut	Ukraine
Informal	28/01/2016 00 UTC	28/01/2016	1	Styr	Ukraine
Informal	27/01/2016 12 UTC	28/01/2016	1	Dnester, above Reut	Moldova
Formal	28/01/2016 12 UTC	29/01/2016	2	Bug, below Mukhavyets	Poland
Informal	31/01/2016 00 UTC	31/01/2016	0	Narew, above Bug	Poland
Informal	30/01/2016 12 UTC	31/01/2016	0	Parnu	Estonia

* Lead time [days] to the first forecasted exceedance of the 5-year simulated discharge threshold.

Table 3: EFAS flash flood notifications sent in December 2015 - January 2016

Type	Forecast date	Issue date	Lead time*	River	Country
Flash flood	03/12/2015 00 UTC	03/12/2015	66	Tay	United Kingdom
Flash flood	03/12/2015 00 UTC	03/12/2015	72	Tyne	United Kingdom
Flash flood	03/12/2015 00 UTC	03/12/2015	66	Esk	United Kingdom
Flash flood	03/12/2015 00 UTC	03/12/2015	18	Coastal zone	United Kingdom
Flash flood	03/12/2015 00 UTC	03/12/2015	66	Erne	United Kingdom
Flash flood	03/12/2015 00 UTC	03/12/2015	66	Foyle	United Kingdom
Flash flood	03/12/2015 00 UTC	03/12/2015	72	Shannon	Irish Republic
Flash flood	03/12/2015 00 UTC	03/12/2015	66	Coastal zone	Irish Republic
Flash flood	03/12/2015 00 UTC	03/12/2015	66	Coastal zone	Irish Republic
Flash flood	03/12/2015 00 UTC	03/12/2015	66	Moy	Irish Republic
Flash flood	03/12/2015 12 UTC	04/12/2015	36	Coastal zone	United Kingdom
Flash flood	10/12/2015 12 UTC	11/12/2015	66	R. Dunkellin	Irish Republic
Flash flood	10/12/2015 12 UTC	11/12/2015	66	Coastal zone	Irish Republic
Flash flood	12/12/2015 00 UTC	12/12/2015	12	Blackwater	Irish Republic
Flash flood	11/12/2015 12 UTC	12/12/2015	24	Suir & Barrow	Irish Republic
Flash flood	11/12/2015 12 UTC	12/12/2015	24	Shannon	Irish Republic
Flash flood	11/12/2015 12 UTC	12/12/2015	24	Shannon	Irish Republic
Flash flood	23/12/2015 12 UTC	24/12/2015	78	Tay	United Kingdom

Flash flood	23/12/2015 12 UTC	24/12/2015	78	R. Eden	United Kingdom
Flash flood	23/12/2015 12 UTC	24/12/2015	78	Coastal zone	United Kingdom
Flash flood	23/12/2015 12 UTC	24/12/2015	78	R. Almond	United Kingdom
Flash flood	26/12/2015 00 UTC	26/12/2015	12	Ouse	United Kingdom
Flash flood	26/12/2015 00 UTC	26/12/2015	12	Ouse	United Kingdom
Flash flood	26/12/2015 00 UTC	26/12/2015	24	Coastal zone	United Kingdom
Flash flood	26/12/2015 00 UTC	26/12/2015	12	Ribble	United Kingdom
Flash flood	26/12/2015 00 UTC	26/12/2015	24	Coastal zone	United Kingdom
Flash flood	26/12/2015 12 UTC	27/12/2015	102	Blackwater	Irish Republic
Flash flood	26/12/2015 12 UTC	27/12/2015	102	Blackwater	Irish Republic
Flash flood	26/12/2015 12 UTC	27/12/2015	102	Blackwater	Irish Republic
Flash flood	26/12/2015 12 UTC	27/12/2015	102	Shannon	Irish Republic
Flash flood	26/12/2015 12 UTC	27/12/2015	102	Nith	United Kingdom
Flash flood	26/12/2015 12 UTC	27/12/2015	102	Coastal zone	United Kingdom
Flash flood	26/12/2015 12 UTC	27/12/2015	108	Coastal zone	United Kingdom
Flash flood	26/12/2015 12 UTC	27/12/2015	108	Coastal zone	United Kingdom
Flash flood	26/12/2015 12 UTC	27/12/2015	108	Coastal zone	United Kingdom
Flash flood	26/12/2015 12 UTC	27/12/2015	108	Teith	United Kingdom
Flash flood	26/12/2015 12 UTC	27/12/2015	108	Tay	United Kingdom
Flash flood	26/12/2015 12 UTC	27/12/2015	108	Tay	United Kingdom
Flash flood	26/12/2015 12 UTC	27/12/2015	108	Southern Esk	United Kingdom
Flash flood	26/12/2015 12 UTC	27/12/2015	108	Dee	United Kingdom
Flash flood	27/12/2015 12 UTC	28/12/2015	78	Suir & Barrow	Irish Republic
Flash flood	27/12/2015 12 UTC	28/12/2015	72	Coastal zone	Irish Republic
Flash flood	27/12/2015 12 UTC	28/12/2015	78	Coastal zone	Irish Republic
Flash flood	27/12/2015 12 UTC	28/12/2015	78	Coastal zone	Irish Republic
Flash flood	27/12/2015 12 UTC	28/12/2015	84	Bann	United Kingdom
Flash flood	28/12/2015 12 UTC	29/12/2015	54	Boyne	Irish Republic
Flash flood	28/12/2015 12 UTC	29/12/2015	54	R. Fane	Irish Republic
Flash flood	28/12/2015 12 UTC	29/12/2015	54	Coastal zone	United Kingdom
Flash flood	01/01/2016 00 UTC	01/01/2016	96	Jucar, above Cabriel	Spain
Flash flood	01/01/2016 00 UTC	01/01/2016	36	Suir & Barrow	Irish Republic
Flash flood	01/01/2016 00 UTC	01/01/2016	84	Coastal zone	United Kingdom
Flash flood	01/01/2016 00 UTC	01/01/2016	78	Don	United Kingdom
Flash flood	01/01/2016 00 UTC	01/01/2016	78	Dee	United Kingdom
Flash flood	01/01/2016 00 UTC	01/01/2016	72	Tay	United Kingdom
Flash flood	01/01/2016 00 UTC	01/01/2016	72	Tay	United Kingdom
Flash flood	02/01/2016 00 UTC	02/01/2016	72	Jucar, above Cabriel	Spain
Flash flood	02/01/2016 00 UTC	02/01/2016	72	Tejo, above Henares	Spain
Flash flood	02/01/2016 12 UTC	03/01/2016	24	Vilaine	France
Flash flood	02/01/2016 12 UTC	03/01/2016	24	Vilaine	France
Flash flood	04/01/2016 00 UTC	04/01/2016	24	Southern Esk	United Kingdom
Flash flood	04/01/2016 00 UTC	04/01/2016	24	Southern Esk	United Kingdom
Flash flood	05/01/2016 00 UTC	05/01/2016	42	Vardar	Albania
Flash flood	04/01/2016 12 UTC	05/01/2016	60	Bann	United Kingdom
Flash flood	06/01/2016 00 UTC	06/01/2016	54	Mino	Spain
Flash flood	06/01/2016 00 UTC	06/01/2016	36	Coastal zone	France
Flash flood	06/01/2016 00 UTC	06/01/2016	36	Coastal zone	France
Flash flood	06/01/2016 00 UTC	06/01/2016	36	Coastal zone	France
Flash flood	06/01/2016 00 UTC	06/01/2016	36	Coastal zone	France
Flash flood	06/01/2016 00 UTC	06/01/2016	24	Boyne	Irish Republic

Flash flood	06/01/2016 00 UTC	06/01/2016	30	Bann	United Kingdom
Flash flood	06/01/2016 00 UTC	06/01/2016	30	Coastal zone	United Kingdom
Flash flood	06/01/2016 00 UTC	06/01/2016	24	Shkumbin	Albania
Flash flood	05/01/2016 12 UTC	06/01/2016	54	Tay	United Kingdom
Flash flood	05/01/2016 12 UTC	06/01/2016	48	Southern Esk	United Kingdom
Flash flood	05/01/2016 12 UTC	06/01/2016	54	Southern Esk	United Kingdom
Flash flood	05/01/2016 12 UTC	06/01/2016	54	Coastal zone	United Kingdom
Flash flood	05/01/2016 12 UTC	06/01/2016	54	Dee	United Kingdom
Flash flood	05/01/2016 12 UTC	06/01/2016	54	Don	United Kingdom
Flash flood	05/01/2016 12 UTC	06/01/2016	54	Deveron	United Kingdom
Flash flood	05/01/2016 12 UTC	06/01/2016	36	R. Fane	Irish Republic
Flash flood	05/01/2016 12 UTC	06/01/2016	48	Vjose	Albania
Flash flood	05/01/2016 12 UTC	06/01/2016	48	Vjose	Albania
Flash flood	07/01/2016 12 UTC	08/01/2016	84	Esla, below Orbigo	Spain
Flash flood	07/01/2016 12 UTC	08/01/2016	84	Esla, below Orbigo	Spain
Flash flood	07/01/2016 12 UTC	08/01/2016	84	Tormes	Spain
Flash flood	07/01/2016 12 UTC	08/01/2016	84	Duoro, below Tormes	Spain
Flash flood	07/01/2016 12 UTC	08/01/2016	90	Duoro, above Pisuerga	Spain
Flash flood	07/01/2016 12 UTC	08/01/2016	90	Duoro, above Pisuerga	Spain
Flash flood	07/01/2016 12 UTC	08/01/2016	96	Jucar, above Cabriel	Spain
Flash flood	07/01/2016 12 UTC	08/01/2016	96	Tejo, above Henares	Spain
Flash flood	09/01/2016 00 UTC	09/01/2016	54	Ebro, above Aragon	Spain
Flash flood	09/01/2016 00 UTC	09/01/2016	48	Ebro, above Aragon	Spain
Flash flood	09/01/2016 00 UTC	09/01/2016	78	Dordogne, above Isle	France
Flash flood	09/01/2016 00 UTC	09/01/2016	54	Duoro, section Adaja to	Spain
Flash flood	10/01/2016 00 UTC	10/01/2016	24	Orbigo	Spain
Flash flood	10/01/2016 00 UTC	10/01/2016	30	Duoro, above Pisuerga	Spain
Flash flood	10/01/2016 00 UTC	10/01/2016	60	Lot	France
Flash flood	10/01/2016 00 UTC	10/01/2016	48	Hron	Slovakia
Flash flood	10/01/2016 00 UTC	10/01/2016	48	Hungary - Tisza	Ukraine
Flash flood	09/01/2016 12 UTC	10/01/2016	36	Pisuerga	Spain
Flash flood	11/01/2016 00 UTC	11/01/2016	36	Dordogne, above Isle	France
Flash flood	11/01/2016 00 UTC	11/01/2016	24	Nitra	Slovakia
Flash flood	24/01/2016 12 UTC	25/01/2016	48	Teith	United Kingdom
Flash flood	25/01/2016 12 UTC	26/01/2016	24	Ness	United Kingdom
Flash flood	27/01/2016 12 UTC	28/01/2016	42	Coastal zone	United Kingdom

* Lead time [hours] to the forecasted peak of the rain storm.

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